(12) UK Patent Application (19) GB (11) 2 226 206 (13) A

(43) Date of A publication 20.06.1990

(21) Application No 8829124.0

(22) Date of filing 14.12.1988

(51) INT CL[5]
H04N 7/13

(52) UK CL (Edition K)
H4F FD3 FD30H FD30K FD30T1 FRC

(56) Documents cited
None

(58) Field of search
UK CL (Edition J) H4F FRC FRW FRX
INT CL[4] H04N

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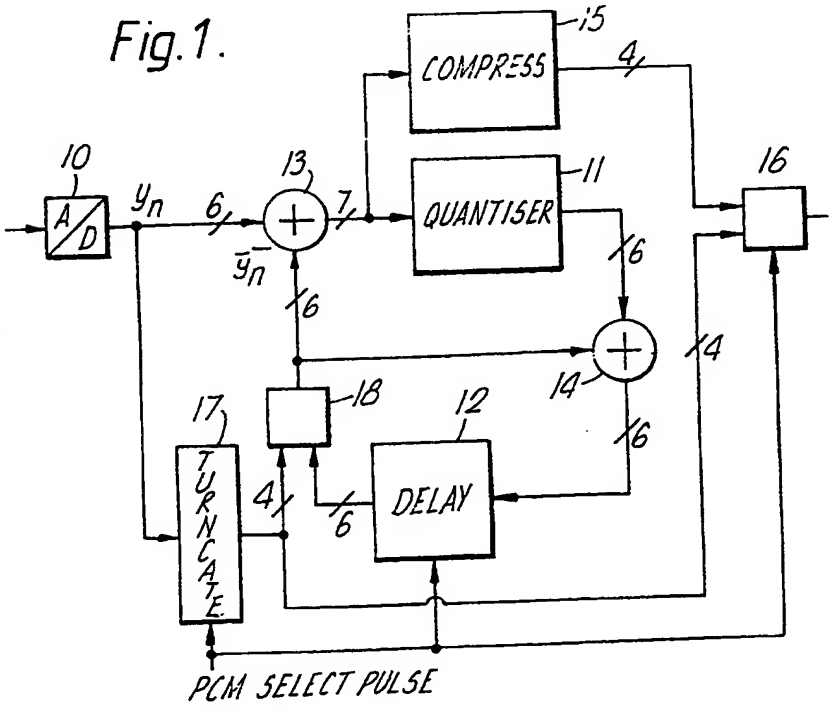
(54) Hybrid PCM/DPCM codec

(57) A hybrid PCM/DPCM encoding arrangement for digitised picture signals in which linearly quantised PCM samples are interleaved at intervals with a large number of DPCM samples, the interleaving of the PCM samples being according to a pseudo-random code sequence the duration of which is equal to the duration of two or more frames of the digitised picture signals. The interleaved PCM samples are used to reset the decoder, thus avoiding transmission error propagation past this point in a TV line.

Fig.1.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy

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Fig. 1.

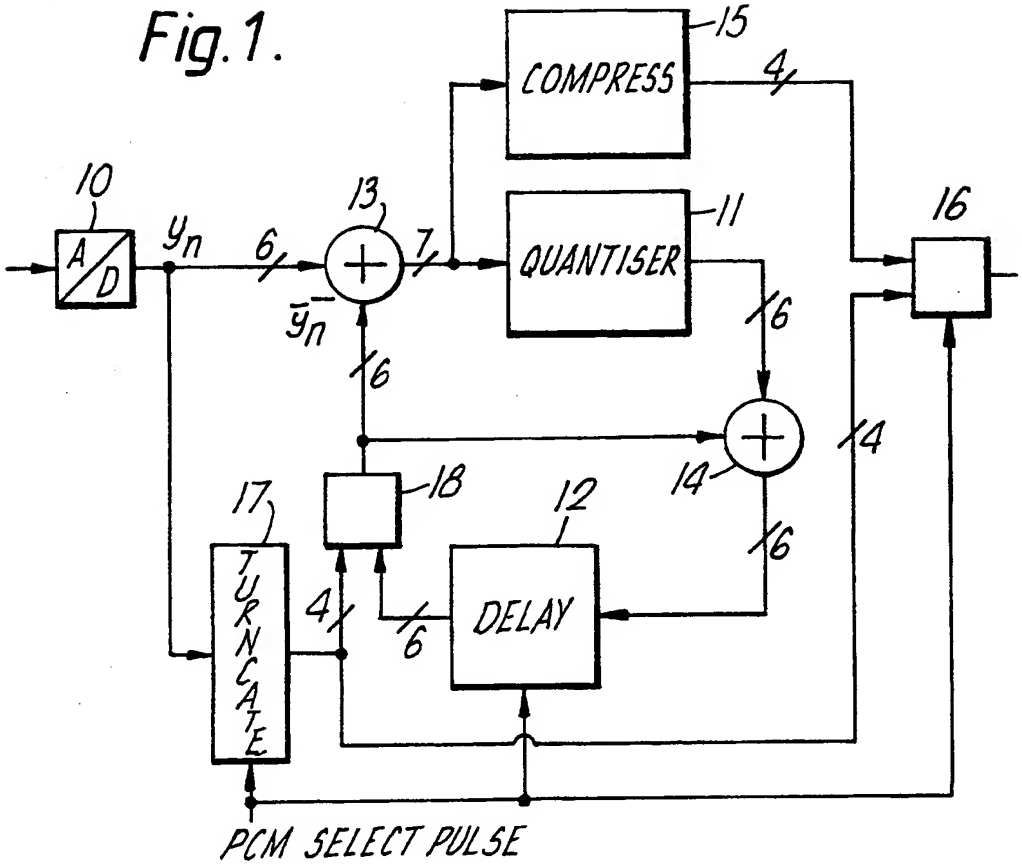
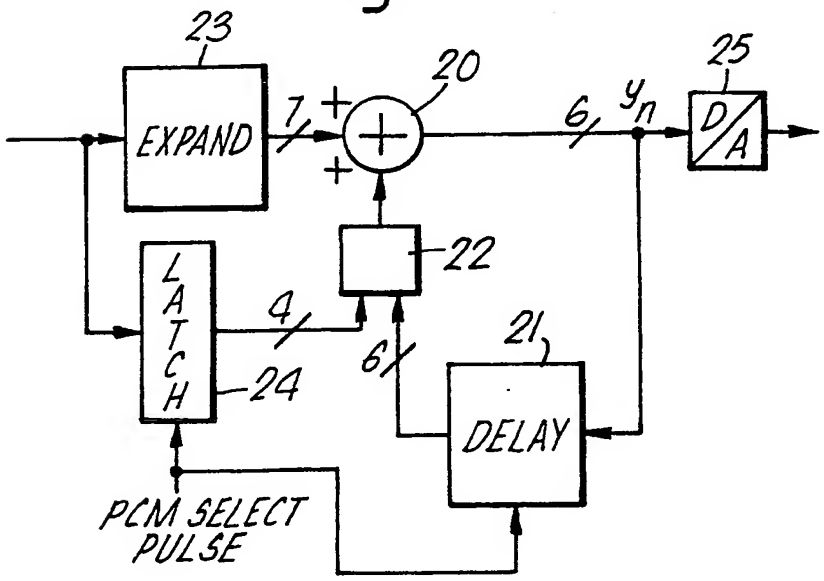

COMPRESS
15
4
10
A/D
y_n
6
13
7
QUANTISER
11
16
$\bar{y}_n$
16
16
14
14
18
12
17
TURNCATE
4
6
DELAY
PCM SELECT PULSE

Fig. 2.


23
EXPAND
7
20
+
+
6
y_n
25
D/A
22
LATCH
4
24
6
21
DELAY
PCM SELECT PULSE

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HYBRID PCM/DPCM CODEC

This invention relates to hybrid PCM/DPCM coding, particularly for the digital transmission of television signals.

Transmission of digital television signals normally requires a considerable number of bits which in turn means that a large bandwidth is necessary. It has long been recognised that some form of bit reduction is desirable and several methods of achieving bit reduction have been proposed. One such method is the so-called "hybrid D-PCM, a combination of PCM and DPCM", Mr C W Van Buul, IEEE Transactions on Communications, Vol. Com-26, No.3, March 1978. In DPCM (Differential Pulse Code Modulation) the amplitude of the incoming analog samples is quantised according to a sliding measuring scale. The scale is referred to as sliding because the zero level of the scale is set at the quantised level of the previous sample. Each sample is then coded with respect to the previous sample. By using a non-linear scale bit reduction is achieved since only the difference between two successive samples is coded.

However, one drawback of simple DPCM coding is that is a transmission error occurs, in the receiver this error is perpetuated, at least until the end of the line, causing a streak in the picture. If the error is]persistent and occurs regularly in the frame then the streak changes from being a transient fault in the picture to one which is highly visible to the viewer.

In hybrid D-PCM as proposed by Van Buul conventional linear PCM information is incorporated into the DPCM code without effectively increasing the bit rate. The advantage of this arrangement is that transmission errors are quickly corrected, due to the PCM content of the signal, while the bit reduction properties of DPCM are retained. However, even with the fast error correction due to the PCM content of the signal regularly occurring errors will still repeat in successive frames sufficiently to "build-up noticeable faults in the picture.

According to the present invention there is provided a hybrid PCM/DPCM encoding arrangement for digitised picture signals in which linearly quantised PCM samples are interleaved at intervals with a larger number of DPCM samples, the interleaving of the PCM samples being according to a pseudo-random code sequence the duration of which is equal to the duration of two or more frames of the digitised picture signals.

According to one aspect of the invention there is provided a hybrid PCM/DPCM encoder for digitised picture signals including an analog-to-digital converter producing linearly quantised PCM encoded signals, a DPCM encoder to which said PCM encoded signals are applied, means for intermittently disabling a feedback loop in said DPCM encoder for one word period, means for inserting a PCM word in the feedback input to the DPCM encoder, and means for inserting the same PCM word into the DPCM encoder output, the means for disabling and the means for inserting each being operative according to a pseudo-random code sequence the duration of which is equal to two or more frames of the digitised picture signals.

According to another aspect of the invention there is provided a decoder for hybrid PCM/DPCM encoded

picture signals including a DPCM decoder to which the encoded signals are applied, means for disabling a feedback loop in the DPCM decoder for one word period and means for selecting from the encoded signals a PCM word for insertion into the feedback input to the DPCM decoder, the means for disabling and the means for inserting each being operative according to a pseudo-random code sequence the duration of which is equal to two or more frames of the digitised picture signals, said pseudo-random sequence being the same as that used in the encoding arrangement for the hybrid PCM/DPCM signals.

Preferably the duration of the pseudo-random sequence exceeds the integration time of the eye, e.g. it is equal to not less than three frame periods.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:-

Fig.1 is a schematic illustration of a hybrid PCM/DPCM encoder, and

Fig.2 is a schematic illustration of a hybrid PCM/DPCM decoder.

The core of the encoder in Fig.1 is a conventional non-linear DPCM coder. Analog signals are first linearly quantised and digitised in A/D converter 10 to form 6-bit PCM words y_n. The PCM words are applied to the DPCM coder comprising quantiser 11, delay 12 and summing circuits 13, 14. This arrangement is substantially the same as that disclosed by Van Buul (supra). The DPCM output is taken via a code converter or compressor 15, which reduces the signals to 4-bit words, to a multiplexer 16. The 6-bit linear PCM words are also applied to a truncator 17 which is hardwired to select 4 bits of the 6-bit words. The output of the truncator 17 is applied to the multiplexer 16. The feedback loop of the DPCM coder includes a second

multiplexer 18 to which the outputs of the delay 12 and the truncator 17 are applied. The output of multiplexer 18, $\overline{y}_n$, is combined with the PCM words in circuit 13 and with the output of the quantiser 11 in circuit 14. The operation of the core DPCM coder is as described by Van Buul, the only difference being that the feedback passes through the multiplexer 18. Truncator 17, delay 12 and multiplexer 16 are all controlled by a pseudo-random code sequence whereby at various intervals truncator 17 is enabled, delay 12 is disabled, and multiplexer 16 substitutes the output of truncator 17 for that of compressor 15. The effect of this is to replace one of the compressed non-linear 4-bit DPCM words with a linear PCM 4-bit word in the encoder output from multiplexer 16. At the same time the DPCM feedback to summing circuit 13 is replaced by the same 4-bit PCM word which in effect resets the DPCM coder. Preferably the pseudo-random code effects this substitution about once in every 20-30 DPCM codewords. Also, the pseudo-random code sequence should be longer than the integration time of the eye, e.g. more than two frames. Because the PCM substitution is pseudo-random and not repeated regularly every frame the slight degradation of the picture in the receiver due to a recurring transmission error will not become obvious to the viewer. The advantage of a short error decay resulting from the introduction of the PCM words in the DPCM stream will, however, be retained.

In the decoder arrangement of Fig. 2 the core DPCM, consisting of summing circuit 20 and feedback delay 21, includes also multiplexer 22 in the feedback circuit. The 4-bit incoming signals are fed through an expander 23 to the summing circuit 20. The incoming signals are also fed to latch 24 the output of which forms the second input to multiplexer 22. The same pseudo-random code used in the encoder is also used to enable latch 24 and disable delay 21 to effect insertion of the required PCM words into the DPCM feedback.

Timing information for the pseudo-random code is transmitted in one of the blanking intervals of the normal transmission. Finally the output of the DPCM decoder is applied to a D/A converter 25.

Claims

1. A hybrid PCM/DPCM encoding arrangement for digitised picture signals in which linearly quantised PCM samples are interleaved at intervals with a larger number of DPCM samples, the interleaving of the PCM samples being according to a pseudo-random code sequence the duration of which is equal to the duration of two or more frames of the digitised picture signals.

2. A hybrid PCM/DPCM encoder for digitised picture signals including an analog-to-digital converter producing linearly quantised PCM encoded signals, a DPCM encoder to which said PCM encoded signals are applied, means for intermittently disabling a feedback loop in said DPCM encoder for one word period, means for inserting a PCM word in the feedback input to the DPCM encoder, and means for inserting the same PCM word into the DPCM encoder output, the means for disabling and the means for inserting each being operative according to a pseudo-random code sequence the duration of which is equal to two or more frames of the digitised picture signals.

3. An encoder according to claim 2 including a multiplexer to which the DPCM and the PCM words are applied, the multiplexer being operative in response to the pseudo-random code to effect insertion of the PCM words in the DPCM coder output.

4. A decoder for hybrid PCM/DPCM encoded picture signals including a DPCM decoder to which the encoded signals are applied, means for disabling a feedback loop in the DPCM decoder for one word period and means for selecting from the encoded signals a PCM word for insertion into the feedback input to the DPCM decoder, the means for disabling and the means for inserting each being operative according to a pseudo-random code sequence the duration of which is equal to two or more

frames of the digitised picture signals, said pseudo-random sequence being the same as that used in the encoding arrangement for the hybrid PCM/DPCM signals.

5. A hybrid PCM/DPCM encoding arrangement substantially as described with reference to the accompanying drawings.

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